ISSN 2307-8960 (online)

World Journal of *Clinical Cases*

World J Clin Cases 2022 May 16; 10(14): 4327-4712

Published by Baishideng Publishing Group Inc

WJCC World Journal of Clinical Cases

Contents

Thrice Monthly Volume 10 Number 14 May 16, 2022

World Journal of Clinical Cases

Thrice Monthly Volume 10 Number 14 May 16, 2022

Contents

World Journal of Clinical Cases

Thrice Monthly Volume 10 Number 14 May 16, 2022

Contents

World Journal of Clinical Cases

Thrice Monthly Volume 10 Number 14 May 16, 2022

Contents

World Journal of Clinical Cases

Thrice Monthly Volume 10 Number 14 May 16, 2022

Contents

ABOUT COVER

Editorial Board Member of *World Journal of Clinical Cases*, Jamir Pitton Rissardo, MD, Academic Research, Adjunct Associate Professor, Research Associate, Department of Medicine, Federal University of Santa Maria, Santa Maria 97105110, Brazil. jamirrissardo@gmail.com

AIMS AND SCOPE

The primary aim of *World Journal of Clinical Cases* (*WJCC*, *World J Clin Cases*) is to provide scholars and readers from various fields of clinical medicine with a platform to publish high-quality clinical research articles and communicate their research findings online.

WJCC mainly publishes articles reporting research results and findings obtained in the field of clinical medicine and covering a wide range of topics, including case control studies, retrospective cohort studies, retrospective studies, clinical trials studies, observational studies, prospective studies, randomized controlled trials, randomized clinical trials, systematic reviews, meta-analysis, and case reports.

INDEXING/ABSTRACTING

The *WJCC* is now indexed in Science Citation Index Expanded (also known as SciSearch®), Journal Citation Reports/Science Edition, Scopus, PubMed, and PubMed Central. The 2021 Edition of Journal Citation Reports® cites the 2020 impact factor (IF) for *WJCC* as 1.337; IF without journal self cites: 1.301; 5-year IF: 1.742; Journal Citation Indicator: 0.33; Ranking: 119 among 169 journals in medicine, general and internal; and Quartile category: Q3. The *WJCC*'s CiteScore for 2020 is 0.8 and Scopus CiteScore rank 2020: General Medicine is 493/793.

RESPONSIBLE EDITORS FOR THIS ISSUE

NAME OF JOURNAL

World Journal of Clinical Cases

ISSN

ISSN 2307-8960 (online)

LAUNCH DATE

April 16, 2013

FREQUENCY

Thrice Monthly

PUBLICATION DATE

May 16, 2022

World Journal of Clinical Cases

Submit a Manuscript: https://www.f6publishing.com

World J Clin Cases 2022 May 16; 10(14): 4327-4333

DOI: 10.12998/wjcc.v10.i14.4327

ISSN 2307-8960 (online)

OPINION REVIEW

Emerging role of biosimilars in the clinical care of inflammatory bowel disease patients

Hala Najeeb, Farah Yasmin, Salim Surani

Specialty type: Gastroenterology and hepatology

Provenance and peer review: Invited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's scientific quality classification

Grade A (Excellent): 0
Grade B (Very good): B
Grade C (Good): C
Grade D (Fair): D
Grade E (Poor): 0

P-Reviewer: Hasan A, Egypt; Lakatos PL, Canada; Yang BL, China

Received: October 27, 2021
Peer-review started: October 27, 2021
First decision: December 12, 2021
Revised: January 20, 2022
Accepted: March 27, 2022
Article in press: March 27, 2022
Published online: May 16, 2022

Hala Najeeb, Farah Yasmin, Department of Internal Medicine, Dow University of Health Sciences, Karachi 74200, Pakistan

Salim Surani, Department of Medicine, Texas A&M University, College Station, TX 77843, United States

Salim Surani, Department of Anesthesiology, Mayo Clinic, Rochester, MN 55905, United States

Corresponding author: Salim Surani, FACP, FCCP, MD, MSc, Doctor, Professor, Department of Medicine, Texas A&M University, 400 Bizzell St, College Station, TX 77843, United States. srsurani@hotmail.com

Abstract

The increasing incidence of inflammatory bowel disease (IBD) globally has redirected the healthcare system's focus towards safe and affordable pharmacological interventions. The inception of anti-tumor necrosis factor-α (TNF-α) had resulted in a trend shift from surgical interventions. However, as the patents of approved anti-TNF-α drugs expire, biological copies of the many approved products are in the pipeline. The most commonly used biosimilar for IBD has been infliximab, followed by Adalimumab biosimilars which have been approved in major countries across the world. Although biosimilars are approved on the basis of similarity of their reference product, the lack of real-world evidence of its safety in ulcerative colitis and Crohn's disease patients has contributed to physicians' hesitancy. However, biosimilars are expected to reduce treatment costs and provide economic benefits.

Key Words: Inflammatory bowel disease; Biosimilars; Anti-tumor necrosis factor; Infliximab; Adalimumab; Ulcerative colitis; Chrons disease

Core Tip: There is limited evidence on the safety and use of biosimilars other than Infliximab. This review explores the role of biosimilars in an era of anti-tumor necrosis factor-α drug as a treatment option for inflammatory bowel disease. The approval of biosimilars by the Food and Drug Administration or European Medicines Agency based on their similarity and functionality to the reference product has raised concerns regarding its efficacy. Many remain hesitant in recommending biosimilars as a viable treatment option, despite its promise of reducing long-term costs. This originates from the lack of clinical trials of biosimilars. Although no serious adverse events have been reported with biosimilars, conclusions cannot be drawn without sufficient empirical evidence.

Citation: Najeeb H, Yasmin F, Surani S. Emerging role of biosimilars in the clinical care of inflammatory bowel disease patients. *World J Clin Cases* 2022; 10(14): 4327-4333
URL: https://www.wjgnet.com/2307-8960/full/v10/i14/4327.htm
DOI: https://dx.doi.org/10.12998/wjcc.v10.i14.4327

INTRODUCTION

The idiopathic Inflammatory Bowel Disease (IBD) phenotypically presents as ulcerative colitis (UC) and as Crohn's disease (CD). Unlike UC, which exclusively affects the colon's mucosal layer, CD damages all layers of the gastrointestinal tract[1]. Clinical presentations that are common to both subtypes include diarrhea and abdominal pain. Rectal bleeding in UC patients and perianal bleeding in CD are caused by excessive chronic inflammation and a dysregulated immune system[2]. A compromised intestinal barrier allows infiltration of leukocytes, and the release of pro-inflammatory cytokines and interleukins (IL) from T-regulatory cells and Th17 cells which exaggerate inflammation. Contributing factors as IL-6, IL-17, interferon-gamma (IFN-γ), free oxidative radicals, and tumor necrosis factor-α (TNF-α); high serum levels and biopsy specimens of TNF-α are definitive markers of CD and colitis[3]. Increased exposure of leukocytes to the lumen antigens exasperates tissue injury[3]. Although the etiology of IBD remains unclear, normal gut flora is increasingly suspected to be affected by environmental and genetic factors, triggering an immune response[4].

The incurable IBD, often regarded as the 'disease of the west,' shows increase incidence and prevalence in developing countries of Asia, Africa, and Europe[2], due to recent industrialization. A review reported a 67% increase in IBD-related deaths until 2017[2], advocating alternate treatment choices that improve quality of life.

Conventional treatment for IBD aims to reduce inflammatory mechanisms, maintain the patient in remissions, and relieve symptoms. Five-aminosalicylates and Sulfazialine are the first-line of treatments for patients suffering from UC. However, Sulfazialine is not well tolerated in allergic patients[5]. The routine use of corticosteroids with Azathioprine and Mesalamine aims to maintain remission rates in UC and CD patients. Long-term complications associated with steroid therapy include hyperglycemia, diabetes mellitus, and aseptic joint necrosis. Moderate to severe CD patients receiving steroid therapy often develop steroid resistance and steroid dependence, which increases the risk of sepsis[6]. The high rates of mortality and relapsed remission rates have become a major attraction for researchers worldwide.

Newer treatments focus on the anti-TNF-α antibody cA2 regime to reduce the major inflammatory stimulus. Of the five approved biologics, the commonly used for IBD are infliximab, adalimumab, and etanercept[7]. The anti-TNF-α antibody cA2 regime has expanded to include the anti-adhesion agents (natalizumab, vedolizumab) and antibodies that inhibit IL 12 and 23 (ustekinumab)[8]. IBD has emerged as a burden on the healthcare system; pharmacological interventions such as anti-TNF- α has emerged as the industry's prime focus compared to surgical procedures[9]. Consequently, the global pharmaceutical market has succeeded in producing therapeutic drugs despite the costs involved[10]. However, as patents for biologics expired, the production of complex drugs, named biosimilars, began in the early 2000s[11].

THE EMERGENCE OF BIOSIMILARS IN AN ERA OF ANTI-TNF-ALPHA

A biosimilar is a biological copy of a Food and Drug Administration (FDA)-approved originator drug that produces no clinical differences compared to the reference product (RP)[8]. Biosimilars such as monoclonal antibodies have a complex quaternary structure that is prone to post-translational modification, and as a result, it may slightly differ from the reference drug[12]. The European Medicines Agency (EMA) laid down a rigorous but accelerated approval pathway in 2005; the Biologics Price Competition and Innovation Act (BPCIA) in 2009 adopted a similar framework, followed by the FDA in 2012. Biosimilars have been designed to introduce competition in the global market while providing

cost-effective solutions to the health industry[10]. The regulatory process explains that expedited biosimilar product approval is possible because of extrapolation. This allows the biosimilar product to be approved for all indications of the originator product without being tested for it; as a result, saving cost for funding to carry out rigorous trials[13].

THE LANDSCAPE OF BIOSIMILARS FOR IBD IN CLINICAL SETTINGS

Given the safety and efficacy of anti-TNF-α monoclonal antibodies, the first biosimilar product for IBD to receive approval was an RP of infliximab; CELLTRION, Inc, Incheon in South Korea developed a biosimilar product CT-P13[14]. The EMA licensed CT-P13 for IBD use in 2013, while FDA did not approve infliximab-dyyb until 2016. Regulatory approval was given based on two randomized clinical trials (RCTs)[12,15] that analyzed similarities in pharmacodynamics and pharmacokinetics to the RP; phase 1 of clinical testing in active rheumatoid arthritis (RA) patients (PLANETRA)[12] and phase 3 in ankylosing spondylitis (AS) patients (PLANETAS)[15] led to CT-P13's approval. Simple extrapolation led to its approval for UC and CD in the United States, the United Kingdom, Europe, Korea, Australia, and Canada[14].

Infliximab biosimilar SB2 (Flixabi or Renflexis) followed a similar approval pathway from the EMA in 2016 and by the FDA in 2017, while PF-06438179 (Zessly) has only been licensed for use in Europe. India's health ministry approved biosimilar BOW015 (Infimab) as a treatment for IBD in 2014[16]; while NI-071[17] and STI-002[18] completed phase III trials in China and Japan, maintaining the safety and efficacy of the RP at the end of the 54-wk study period.

Another anti-TNF-α IgG1 monoclonal antibody, Adalimumab (ADA) originator, had the expiry of their patents in 2016 in the United States and 2018 in Europe[19,20]. Since then, biosimilars for ADA have been introduced in the clinical setting. The first ADA biosimilar to gain approval was ABP 501 (Amigen) by the FDA in 2016 and the EMA in 2017. The 52-wk clinical trial of ABP 501 in moderate-to-severe RA patients[21] and psoriasis patients[21] concluded that there were no significant differences between the biosimilar and the RP in the efficacy (PASI scores and ACR20 Levels). SB5 (Imraldi), a biosimilar product of ADA, was approved by the EMA in 2017 and exhibited similar pharmacokinetics and response rates (72%) at 24 wk of the trial[22].

Table 1 summarizes the list of biosimilars, originator products, and the country of approval. However, it is essential to note that most biosimilar products were only clinically tested in RA or AS patients. VOLTAIRE®-PK trial of BI 695501[23], a biosimilar product of the originator ADA serves as an example of clinical trials among healthy volunteers. EMA has approved three infliximab biosimilars (CT-P13, SB2, and PF-06438179/GP1111) and five adalimumab biosimilars (ABP501, SB5, FKB327, GP2017, and MSB11022) for all complications of the RP and, therefore, IBD subtypes. However, in the United States, only two infliximab biosimilars (CT-P13, SB2) and three adalimumab biosimilars (ABP501, SB5, GP2017) are FDA-licensed for use[24]. Nonetheless, a snapshot review from 2020 reports the increasing trend of biosimilar approvals in the United States, showing the United States government's interest to encourage cost-effectiveness[25].

Introducing competition in the market reportedly decreased the listed prices of originator products for IBD treatment in the European market[26]. With the biosimilar product's introduction to the market, the UK and France saw a decrease in the sales of the originator infliximab[27]. A stochastic-cost model of the Netherlands predicted a significant reduction in UC and CD patients' hospitalization charges and originator product prices over five years[24].

REAL-WORLD EVIDENCE AND THE STANCE OF HEALTHCARE PROFESSIONALS ON BIOSIMILARS FOR IBD

Despite the case-by-case consideration of each biosimilar before its approval, extrapolation has raised concerns about its safety amongst clinicians. A cohort described the acceptance rates of biosimilars among gastroenterologists; 80% of physicians prescribed the first-line originator treatment over biosimilars[26]. In another study that assessed physicians' willingness to switch from infliximab, 72.8% refrained from prescribing biosimilars. Of the 23.7% prescribed biosimilars and biologics, only 60% switched patients from originator treatment to biosimilars[28].

The European Crohn's Colitis Organisation (ECCO) and IBD societies had raised caution against biosimilar drugs approved for IBD[29]. A position paper by the Spanish Agency of Medicines and Medical Devices expressed disagreement with the EMA's approval of biosimilars[30]. Reluctance to prescribe biosimilars lies in its approval process, which does not require large clinical trials. Additionally, the lack of real-world evidence for each approved biosimilar product and the consequences of "switching" is unclear. In the European region, the physician determines if switching from one medicine to another is required based on the clinical effects' similarity. Contrary to the practices in Europe, interchangeability is carried out between biologics and biosimilars at the pharmacy

Table 1 Summary of originator biologic products of tumor necrosis factor-α inhibitors and biosimilars

Product	Biosimilar	Country/year	Status
Infliximab (Remicade, Janssen)	CT-P13 (Inflectra or Remsima, Celltrion Healthcare)	USA, EU, Japan	Approved
	SB2 (Flixabi or Renflexis)	EU, Korea, Australia, USA	Approved
	PF-06438179 or GP1111 (Zessly)	EU-2019	Approved
	BOW015 (Infimab)	India-2014, USA, Canada, Europe, Thailand	Approved; pending market approval
	CMAB008	China-2020	Under review/submitted
	Baimaibo	China-2019	Under review/submitted
	NI-071	Japan-2019	Ongoing-Phase III trial completed
	STI-002	China-2016	Ongoing-Phase III trial completed
Adalimumab (Humira, AbbVie)	ABP 501 (Amgen)	USA-2016, Europe-2017	Approved
	SB5 (Imraldi)	Europe-2017	Approved
	ZRC-3197 (Exemptia)	India-2014	Approved
	BI 695501	USA-2017	Approved
	GP2017	Europe-2017	Approved
	FKB327 (Huilo)	Europe-2019	Approved
	PF-06410293 (Amsparity/Abrilada)	Europe and USA-2020	Approved
	LBAL (Adalimumab BS MA)	Japan-2021	Approved
	CHS-1420	USA-2021	Ongoing-Phase III trial completed
	ONS-3010	Europe-2018	Ongoing-Phase III trial
	BOW050	Europe-2017	Under review
	MSB11022	Europe-2019	Under review
	M923	-	Discontinued
Golimumab	BOW100	-	Under review
	BAT2506	Europe and USA	Ongoing-Phase III trial
Certolizumab	PF688	USA	Under review
Pegol	Xcimzane	-	Ongoing

EU: European Union; USA: United States.

level in the United States, without a healthcare worker's expert opinion [31].

The NOR-SWITCH trial[32] and PROSIT-BIO[33] observational cohorts support the switch from Infliximab to CT-P131 in IBD patients; Massimi *et al*[34] in a prospective study of UC and CD patients from 2021, verified a safe switch from Infliximab to SB2 biosimilar product. A meta-analysis in 2017 analyzed 11 observational studies for the efficacy of CT-P131 in comparison with the Infliximab originator[33]; a recent network meta-analysis concluded that CT-P131's pharmacodynamics is an excellent treatment for remission maintenance. Thus, physicians are confident prescribing infliximab biosimilars, but not biosimilars of other approved anti-TNF-α treatments.

MARKET SALES OF BIOSIMILARS WORLDWIDE

A study from 2021 concluded that Europe dominated the biosimilars market share worldwide by 50%, forecasted to top the charts until 2030[35]. Despite the increasing incidence of chronic diseases, biosimilar sales staggered to achieve 9% of the projected $1 billion cost savings[36]. Due to a lack of definitive standards for approval, adequate profitability, and the risks involved in switching, the United States' biosimilars market growth remains stagnant[37].

FUTURE CHALLENGES AND RECOMMENDATIONS

The lack of empirical evidence and real-world data about the safety of biosimilars in different population groups diagnosed with IBD remains a concern. A study enrolled 42 patients with CD or UC and reported no changes in C-reactive protein, erythrocyte sedimentation rate, or albumin[38]. However, studies with larger sample sizes are required to draw a safe conclusion. Non-medical switching from biologics to biosimilars may ensue a treatment failure, namely the "nocebo effect". In this case, the differences could arise from the individuals' response to the unidentical molecules of the biosimilars. Additionally, 38% of the patients who were switched from originator therapy to biosimilars were unaware of the switch[39]; consultation, written or verbal consent, and patient-doctor communication can minimize the nocebo effect in such patients[40].

Double switch[41] from originator to biosimilars and from one biosimilar to another has recently emerged as a new concern for safety, efficacy, and cost-effectiveness. With patents expiring and multiple biosimilars under review, such queries are bound to emerge more frequently, requiring regulatory bodies' guidelines.

The practice of tendering regulates the cost and availability of pharmaceuticals at the hospital level across Europe. While awarding grants, tendering bodies account for biosimilars and biologics' cost, efficacy, and safety[42]. Tenders may focus on immediate cost reduction of biologics or decrease suppliers and market competition[43].

It is imperative to understand the prospect of IBD patients who experience a secondary loss of response to anti-TNF-α biologic. With only one study measuring the cross-reactivity of anti-infliximab antibodies to infliximab-dyyb in IBD patients, the treatment of such individuals becomes a challenge [13].

Though biosimilars are estimated to reduce costs, the extent of savings and insurance costs are unclear to the patients. Non-medical switching is concerning as insurance companies and government policies might favor adopting biosimilars entirely, even if not required. New data from upcoming studies is necessary to bridge the knowledge gap in healthcare professionals. Overcoming physicians' hesitancy to prescribe biosimilars is required to increase public health literacy while communicating the evidence-based risks in biologics or biosimilars[29].

CONCLUSION

The introduction of biosimilars is expected to reduce the economic burden on the healthcare system while allowing the repurposing of funds towards life-saving drugs and procedures. Based on the available literature, biosimilars are safe and efficacious alternatives to anti-TNF biologic drugs for patients with Inflammatory Bowel Disease. It is important that clinicians should be familiar with the biosimilars, its approval process, cost, safety profile, and the clinical efficacy to help provide the best cost-effective care for their patients. The varying trends in biosimilar research, approvals, and marketing sales point towards them becoming a standard treatment option, with regulatory bodies playing an essential role in deciding. Phase III and IV clinical trials of biosimilar products and real-world comparison of originator and biosimilar are required to improve biosimilar advocacy and education.

FOOTNOTES

Author contributions: Najeeb H and Yasmin F contributed to the conception of the study, primary drafting of the work, final approval, and agreeing to the accuracy of the work; Surani S contributed to the supervision, critical revision of the work, final approval, and review of the accuracy of the work.

Conflict-of-interest statement: The authors declare that they have no conflict of interest.

Country/Territory of origin: United States

ORCID number: Hala Najeeb 0000-0001-7075-4674; Farah Yasmin 0000-0002-5264-6140; Salim Surani 0000-0001-7105-4266.

S-Editor: Chen YL
L-Editor: A
P-Editor: Chen YL

REFERENCES

1 **Lee SH**, Kwon JE, Cho ML. Immunological pathogenesis of inflammatory bowel disease. *Intest Res* 2018; **16**: 26-42 [PMID: 29422795 DOI: 10.5217/ir.2018.16.1.26]

2 **GBD 2017 Inflammatory Bowel Disease Collaborators**. The global, regional, and national burden of inflammatory bowel disease in 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet Gastroenterol Hepatol* 2020; **5**: 17-30 [PMID: 31648971 DOI: 10.1016/S2468-1253(19)30333-4]

3 **Ramos GP**, Papadakis KA. Mechanisms of Disease: Inflammatory Bowel Diseases. *Mayo Clin Proc* 2019; **94**: 155-165 [PMID: 30611442 DOI: 10.1016/j.mayocp.2018.09.013]

4 **M'Koma AE**. Inflammatory bowel disease: an expanding global health problem. *Clin Med Insights Gastroenterol* 2013; **6**: 33-47 [PMID: 24833941 DOI: 10.4137/CGast.S12731]

5 **Taylor KM**, Irving PM. Optimization of conventional therapy in patients with IBD. *Nat Rev Gastroenterol Hepatol* 2011; **8**: 646-656 [PMID: 21970871 DOI: 10.1038/nrgastro.2011.172]

6 **Pithadia AB**, Jain S. Treatment of inflammatory bowel disease (IBD). *Pharmacol Rep* 2011; **63**: 629-642 [PMID: 21857074 DOI: 10.1016/s1734-1140(11)70575-8]

7 **Perše M**, Unkovič A. The Role of TNF in the Pathogenesis of Inflammatory Bowel Disease. *Biol Ther Inflamm Bowel Dis* 2019 [DOI: 10.5772/intechopen.84375]

8 **Food and Drug Administration**. Biosimilars. [cited 26 Sep 2021]. Available from: https://www.fda.gov/drugs/therapeutic-biologics-applications-bla/biosimilars

9 **van der Valk ME**, Mangen MJ, Leenders M, Dijkstra G, van Bodegraven AA, Fidder HH, de Jong DJ, Pierik M, van der Woude CJ, Romberg-Camps MJ, Clemens CH, Jansen JM, Mahmmod N, van de Meeberg PC, van der Meulen-de Jong AE, Ponsioen CY, Bolwerk CJ, Vermeijden JR, Siersema PD, van Oijen MG, Oldenburg B; COIN study group and the Dutch Initiative on Crohn and Colitis. Healthcare costs of inflammatory bowel disease have shifted from hospitalisation and surgery towards anti-TNFα therapy: results from the COIN study. *Gut* 2014; **63**: 72-79 [PMID: 23135759 DOI: 10.1136/gutjnl-2012-303376]

10 **Rawla P**, Sunkara T, Raj JP. Role of biologics and biosimilars in inflammatory bowel disease: current trends and future perspectives. *J Inflamm Res* 2018; **11**: 215-226 [PMID: 29844695 DOI: 10.2147/JIR.S165330]

11 **Gomollón F**. Biosimilars in inflammatory bowel disease: ready for prime time? *Curr Opin Gastroenterol* 2015; **31**: 290-295 [PMID: 26039720 DOI: 10.1097/MOG.0000000000000184]

12 **Yoo DH**, Hrycaj P, Miranda P, Ramiterre E, Piotrowski M, Shevchuk S, Kovalenko V, Prodanovic N, Abello-Banfi M, Gutierrez-Ureña S, Morales-Olazabal L, Tee M, Jimenez R, Zamani O, Lee SJ, Kim H, Park W, Müller-Ladner U. A randomised, double-blind, parallel-group study to demonstrate equivalence in efficacy and safety of CT-P13 compared with innovator infliximab when coadministered with methotrexate in patients with active rheumatoid arthritis: the PLANETRA study. *Ann Rheum Dis* 2013; **72**: 1613-1620 [PMID: 23687260 DOI: 10.1136/annrheumdis-2012-203090]

13 **Rudrapatna VA**, Velayos F. Biosimilars for the Treatment of Inflammatory Bowel Disease. *Pract Gastroenterol* 2019; **43**: 84-91 [PMID: 31435122]

14 **Ben-Horin S**, Vande Casteele N, Schreiber S, Lakatos PL. Biosimilars in Inflammatory Bowel Disease: Facts and Fears of Extrapolation. *Clin Gastroenterol Hepatol* 2016; **14**: 1685-1696 [PMID: 27215364 DOI: 10.1016/j.cgh.2016.05.023]

15 **Park W**, Hrycaj P, Jeka S, Kovalenko V, Lysenko G, Miranda P, Mikazane H, Gutierrez-Ureña S, Lim M, Lee YA, Lee SJ, Kim H, Yoo DH, Braun J. A randomised, double-blind, multicentre, parallel-group, prospective study comparing the pharmacokinetics, safety, and efficacy of CT-P13 and innovator infliximab in patients with ankylosing spondylitis: the PLANETAS study. *Ann Rheum Dis* 2013; **72**: 1605-1612 [PMID: 23687259 DOI: 10.1136/annrheumdis-2012-203091]

16 **Biosimilars of infliximab**. [cited 27 Sep 2021]. Available from: https://www.gabionline.net/biosimilars/general/Biosimilars-of-infliximab

17 **Matsuno H**, Matsubara T. A randomized double-blind parallel-group phase III study to compare the efficacy and safety of NI-071 and infliximab reference product in Japanese patients with active rheumatoid arthritis refractory to methotrexate. *Mod Rheumatol* 2019; **29**: 919-927 [PMID: 30289287 DOI: 10.1080/14397595.2018.1533063]

18 **Durez P**, Malghem J, Nzeusseu Toukap A, Depresseux G, Lauwerys BR, Westhovens R, Luyten FP, Corluy L, Houssiau FA, Verschueren P. Treatment of early rheumatoid arthritis: a randomized magnetic resonance imaging study comparing the effects of methotrexate alone, methotrexate in combination with infliximab, and methotrexate in combination with intravenous pulse methylprednisolone. *Arthritis Rheum* 2007; **56**: 3919-3927 [PMID: 18050189 DOI: 10.1002/art.23055]

19 **Simoens S**. Biosimilar medicines and cost-effectiveness. *Clinicoecon Outcomes Res* 2011; **3**: 29-36 [PMID: 21935330 DOI: 10.2147/CEOR.S12494]

20 **Cingolani L**, Barberio B, Zingone F, Ferronato A, Bertani L, Costa F, Bodini G, Demarzo MG, Melatti P, Gubbiotti A, Massimi D, Casadei C, D'Incà R, Savarino EV. Adalimumab biosimilars, ABP501 and SB5, are equally effective and safe as adalimumab originator. *Sci Rep* 2021; **11**: 10368 [PMID: 33990652 DOI: 10.1038/s41598-021-89790-4]

21 **Papp K**, Bachelez H, Costanzo A, Foley P, Gooderham M, Kaur P, Philipp S, Spelman L, Zhang N, Strober B. Clinical similarity of the biosimilar ABP 501 compared with adalimumab after single transition: long-term results from a randomized controlled, double-blind, 52-week, phase III trial in patients with moderate-to-severe plaque psoriasis. *Br J Dermatol* 2017; **177**: 1562-1574 [PMID: 28755394 DOI: 10.1111/bjd.15857]

22 **Weinblatt ME**, Baranauskaite A, Niebrzydowski J, Dokoupilova E, Zielinska A, Jaworski J, Racewicz A, Pileckyte M, Jedrychowicz-Rosiak K, Cheong SY, Ghil J. Phase III Randomized Study of SB5, an Adalimumab Biosimilar, Versus Reference Adalimumab in Patients With Moderate-to-Severe Rheumatoid Arthritis. *Arthritis Rheumatol* 2018; **70**: 40-48 [PMID: 28950421 DOI: 10.1002/art.40336]

23 **Wynne C**, Altendorfer M, Sonderegger I, Gheyle L, Ellis-Pegler R, Buschke S, Lang B, Assudani D, Athalye S, Czeloth N. Bioequivalence, safety and immunogenicity of BI 695501, an adalimumab biosimilar candidate, compared with the reference biologic in a randomized, double-blind, active comparator phase I clinical study (VOLTAIRE®-PK) in healthy subjects. *Expert Opin Investig Drugs* 2016; **25**: 1361-1370 [PMID: 27813422 DOI: 10.1080/13543784.2016.1255724]

24 **Solitano V**, D'Amico F, Fiorino G, Peyrin-Biroulet L, Danese S. Biosimilar switching in inflammatory bowel disease: from evidence to clinical practice. *Expert Rev Clin Immunol* 2020; **16**: 1019-1028 [PMID: 32954893 DOI: 10.1080/1744666X.2021.1826311]

25 **Gherghescu I**, Delgado-Charro MB. The Biosimilar Landscape: An Overview of Regulatory Approvals by the EMA and FDA. *Pharmaceutics* 2020; **13** [PMID: 33396369 DOI: 10.3390/pharmaceutics13010048]

26 **Entrepreneurship and SMEs**. The impact of biosimilar competition on price, volume and market. 2017 [cited 2021 Sep 27]. Available from: https://ec.europa.eu/growth/content/impact-biosimilar-competition-price-volume-and-market-share-update-2017_en

27 **Kim Y**, Kwon HY, Godman B, Moorkens E, Simoens S, Bae S. Uptake of Biosimilar Infliximab in the UK, France, Japan, and Korea: Budget Savings or Market Expansion Across Countries? *Front Pharmacol* 2020; **11**: 970 [PMID: 32733238 DOI: 10.3389/fphar.2020.00970]

28 **Chen AJ**, Gascue L, Ribero R, Van Nuys K. Uptake of Infliximab Biosimilars Among the Medicare Population. *JAMA Intern Med* 2020; **180**: 1255-1256 [PMID: 32702080 DOI: 10.1001/jamainternmed.2020.3188]

29 **Danese S**, Fiorino G, Raine T, Ferrante M, Kemp K, Kierkus J, Lakatos PL, Mantzaris G, van der Woude J, Panes J, Peyrin-Biroulet L. ECCO Position Statement on the Use of Biosimilars for Inflammatory Bowel Disease-An Update. *J Crohns Colitis* 2017; **11**: 26-34 [PMID: 27927718 DOI: 10.1093/ecco-jcc/jjw198]

30 **Argüelles-Arias F**, Barreiro-de-Acosta M, Carballo F, Hinojosa J, Tejerina T. Joint position statement by "Sociedad Español a de Patología Digestiva" (Spanish Society of Gastroenterology) and "Sociedad Española de Farmacología" (Spanish Society of Pharmacology) on biosimilar therapy for inflammatory bowel disease. *Rev Esp Enferm Dig* 2013; **105**: 37-43 [PMID: 23548008 DOI: 10.4321/s1130-01082013000100006]

31 **Gecse KB**, Lakatos PL. Biosimilar Monoclonal Antibodies for Inflammatory Bowel Disease: Current Comfort and Future Prospects. *Drugs* 2016; **76**: 1413-1420 [PMID: 27638739 DOI: 10.1007/s40265-016-0638-4]

32 **Jørgensen KK**, Olsen IC, Goll GL, Lorentzen M, Bolstad N, Haavardsholm EA, Lundin KEA, Mørk C, Jahnsen J, Kvien TK; NOR-SWITCH study group. Switching from originator infliximab to biosimilar CT-P13 compared with maintained treatment with originator infliximab (NOR-SWITCH): a 52-week, randomised, double-blind, non-inferiority trial. *Lancet* 2017; **389**: 2304-2316 [PMID: 28502609 DOI: 10.1016/S0140-6736(17)30068-5]

33 **Komaki Y**, Yamada A, Komaki F, Micic D, Ido A, Sakuraba A. Systematic review with meta-analysis: the efficacy and safety of CT-P13, a biosimilar of anti-tumour necrosis factor-α agent (infliximab), in inflammatory bowel diseases. *Aliment Pharmacol Ther* 2017; **45**: 1043-1057 [PMID: 28239873 DOI: 10.1111/apt.13990]

34 **Massimi D**, Barberio B, Bertani L, Costa F, Ferronato A, Facchin S, Cardin R, Cingolani L, Casadei C, D'Incà R, Zingone F, Savarino EV. Switching from Infliximab Originator to SB2 Biosimilar in Inflammatory Bowel Diseases: A Multicentric Prospective Real-Life Study. *Therap Adv Gastroenterol* 2021; **14**: 17562848211023384 [PMID: 34249147 DOI: 10.1177/17562848211023384]

35 **Precedence Research in Globe News Wire**. Biosimilars Market Size to Surpass US $66.2 Billion. 2021 [cited 2022 Mar 16]. Available from: https://www.globenewswire.com/news-release/2021/11/18/2337625/0/en/Biosimilars-Market-Size-to-Surpass-US-66-2-Billion-by-2030.html

36 **Yazdany J**. Failure to Launch: Biosimilar Sales Continue to Fall Flat in the United States. *Arthritis Rheumatol* 2020; **72**: 870-873 [PMID: 31922346 DOI: 10.1002/art.41203]

37 **Growth-Mordor Intelligence**. Global Biosimilars Market. 2021 [cited 2022 Jan 19]. Available from: https://www.mordorintelligence.com/industry-reports/global-biosimilars-market-industry

38 **Van Hoeve K**, Dreesen E, Hoffman I, Van Assche G, Ferrante M, Gils A, Vermeire S. Efficacy, Pharmacokinetics, and Immunogenicity is Not Affected by Switching From Infliximab Originator to a Biosimilar in Pediatric Patients With Inflammatory Bowel Disease. *Ther Drug Monit* 2019; **41**: 317-324 [PMID: 30633088 DOI: 10.1097/FTD.0000000000000601]

39 **Fleischmann R**, Jairath V, Mysler E, Nicholls D, Declerck P. Nonmedical Switching From Originators to Biosimilars: Does the Nocebo Effect Explain Treatment Failures and Adverse Events in Rheumatology and Gastroenterology? *Rheumatol Ther* 2020; **7**: 35-64 [PMID: 31950442 DOI: 10.1007/s40744-019-00190-7]

40 **Boone NW**, Liu L, Romberg-Camps MJ, Duijsens L, Houwen C, van der Kuy PHM, Janknegt R, Peeters R, Landewé RBM, Winkens B, van Bodegraven AA. The nocebo effect challenges the non-medical infliximab switch in practice. *Eur J Clin Pharmacol* 2018; **74**: 655-661 [PMID: 29368188 DOI: 10.1007/s00228-018-2418-4]

41 **Trystram N**, Abitbol V, Tannoury J, Lecomte M, Assaraf J, Malamut G, Gagnière C, Barré A, Sobhani I, Chaussade S, Amiot A. Outcomes after double switching from originator Infliximab to biosimilar CT-P13 and biosimilar SB2 in patients with inflammatory bowel disease: a 12-month prospective cohort study. *Aliment Pharmacol Ther* 2021; **53**: 887-899 [PMID: 33647174 DOI: 10.1111/apt.16312]

42 **Simoens S**, Cheung R. Tendering and biosimilars: what role for value-added services? *J Mark Access Health Policy* 2020; **8**: 1705120 [PMID: 32002174 DOI: 10.1080/20016689.2019.1705120]

43 **AJMC Center of Biosimilars**. Survey: Union Needs to Fine-tune Its Biosimilars Procurement. European 2021 [cited 2022 Mar 16]. Available from: https://www.centerforbiosimilars.com/view/survey-european-union-needs-to-fine-tune-its-biosimilars-procurement-process

Published by **Baishideng Publishing Group Inc**
7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA
Telephone: +1-925-3991568
E-mail: bpgoffice@wjgnet.com
Help Desk: https://www.f6publishing.com/helpdesk
https://www.wjgnet.com